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November 1995

DOCUMENT DELIVERY SYSTEM

Harris Corporation

Tim Lucas, Herb Hobgood, and Robert Brown

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Rome Laboratory
Air Force Materiel Command
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The Document Delivery System (DDS) improves NAIC's dissemination of foreign scientific and technical intelligence information through the replacement of the current microfiche-based sortage, duplication, and delivery with a CD-ROM-based document delivery system. DDS consists of a Master Production System (MPS) and three Remote Scanning Stations (RSSs). Retrieval Stations (RSs) are used to retrieve data on CD-ROM that was produced by the MPS at NAIC. This report addresses the technical design and implementation of those components that comprise the MPS and RSS.

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1.0 DDS OVERVIEW

The Document Delivery System (DDS) improves NAIC's dissemination of foreign Scientific and Technical Intelligence information through the replacement of the current microfiche-based storage, duplication, and delivery system with a CD-ROM-based document delivery system. DDS consists of a Master Production System (MPS) and three Remote Scanning Station (RSSs). Retrieval Stations (RSs) are used to retrieve data on CD-ROM that was produced by the MPS at NAIC. This final technical report shall address the technical design and implementation of those components that comprise the MPS and RSS.

1.1 Background

The purpose of the DDS program was to provide a more efficient use of manpower and physical space to both NAIC and its customers through the use of CD-ROM read/write technology.

NAIC currently maintains the Central Information Reference and Control System (CIRC) library in microfiche form for use by the National Intelligence community and Government sponsored R&D organizations. Documents are input to CIRC in digital, hardcopy, and microfiche form, and are converted, stored, and distributed to users as microfiche; only brief document references and abstracts are entered in the CIRC on-line system. Customers have been dropping out of the old microfiche-based system over the last few years and have expressed a desire to use a new technology.

CD-ROM technology promises to make the retrieval of intelligence information much faster and simpler than the traditional microfiche technology. NAIC shall use DDS as the new state-of-the-art way to distribute documents to its customers.

1.2 DDS Mission Concepts

DDS consists of hardware and software to perform document imaging, compression, CD mastering/playback, and the security features to meet the requirements for processing SCI and Collateral data. The sections which follow address the operational concepts of DDS.

1.2.1 User Needs

The Master Production System (MPS) was designed for NAIC. The users at NAIC need a system which allows for scanning documents of various types, and a CD Authoring system to create CD-ROM's. Hardware and software was integrated to form a capability to scan in documents into a PC hard drive, manage those documents using the Document Management software, transfer the digital version of the documents onto 8mm tape or send it over an Ethernet to another PC, where an ISO 9660 image of the document(s) shall be written onto a Write-Once CD (WO-CD). A CD Authoring system exists in a SCIF and in a Collateral area.

The users at the Remote Scanning Stations (RSSs) need a system for scanning documents and storing them onto a magnetic media, which can later be sent to NAIC. Hardware and software was

integrated to form a capability to scan in documents into a PC hard drive, manage those documents using the Document Management software, transfer the digital version of the documents onto 8mm tape.

The RS users need a system in which they can search and retrieve on pre-specified fields (document # as a minimum) of a CIRC CD-ROM. The CD Answer system meets this need.

1.2.2 Primary Mission

The primary mission is met by the Master Production Facility, which serves as the CD mastering facility for all CIRC documents. Digital and hardcopy documents are read/scanned in and are put onto CD-ROM as they come in. Once sufficient documents are scanned in to fill a CD-ROM, each is assigned a CD-ROM number, recorded in ORACLE/CUE, duplicated and distributed out to the customer base.

1.2.3 Secondary Mission

DDS has as its secondary mission to serve the entire base of customers, providing them with timely updates of CD-ROMs as they are created. The end-users will have a PC with a CD-ROM player and CD Answer software which enables them to search on specific text fields and retrieve/view documents on the CD-ROM.

1.2.4 Operational Environment for Document Retrieval

Figure 1-1 illustrates the operational setting for a DDS site. There are presently 50 of these sites which will receive CD-ROMs periodically from NAIC containing all of the CIRC documents which have been processed during that time period. Each CD is to be labelled with the NAIC logo, the classification, and the CD-ROM number.

1.3 Terminology

A "station" in DDS is a IBM-compatible 486 PC, with the supporting equipment, including scanners, monitors, and CD devices. The "Master Production System" consists of Stations 1, 2, 2A, 3, 4, 4A, and 5. The "Remote Scanning Stations" collectively are referred to by the designator Station 6. Stations 1, 2, 2A are used for SCI level processing, and Stations 3, 4, 4A, and 5 are used for Collateral level processing. Stations 1, 3, and 5 are used for scanning documents. Stations 2 and 4 are used for CD Mastering. Stations 2A and 4A are used as the quality control stations.

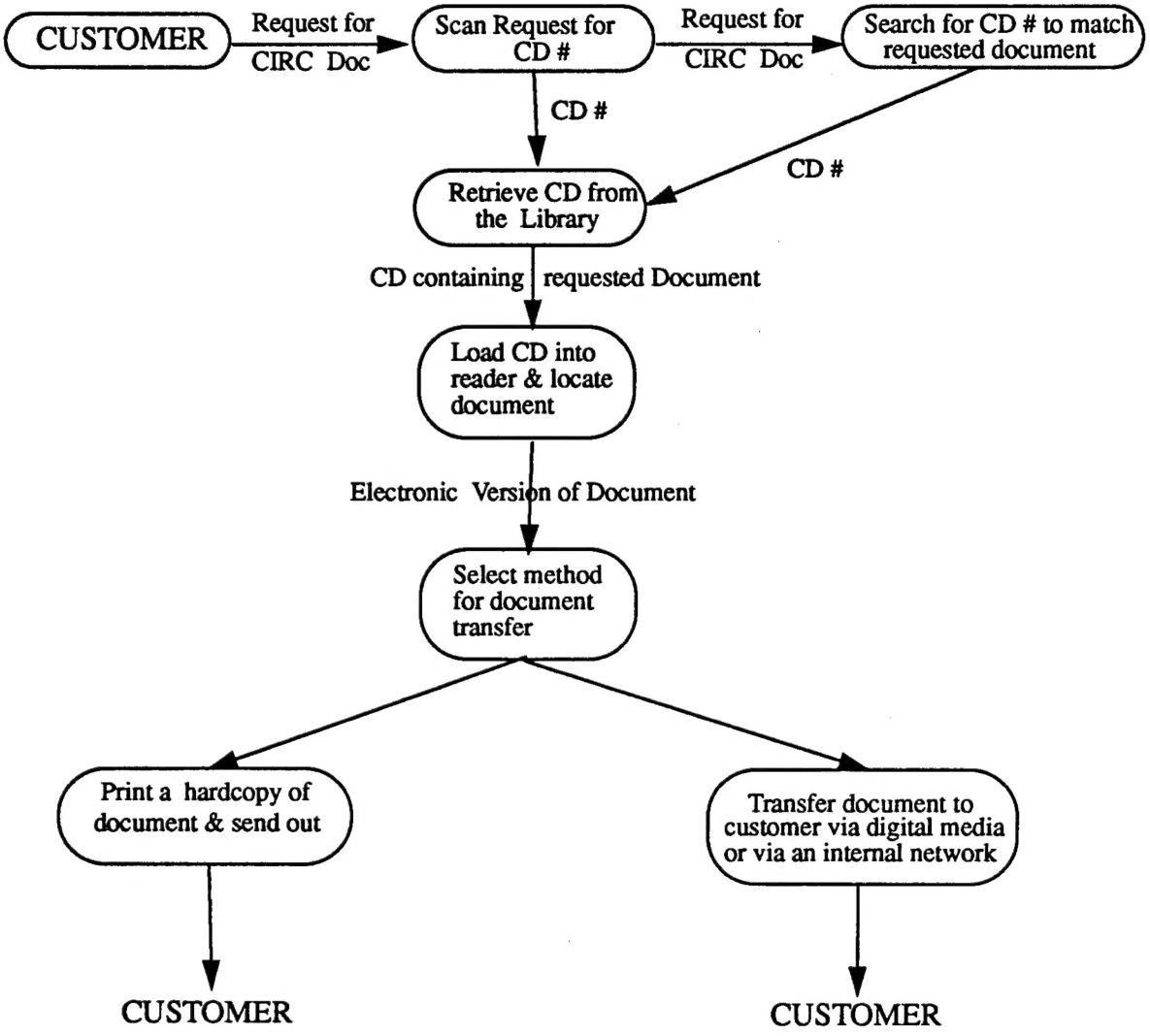


Figure 1-1. Operational Environment for Document Retrieval at a DDS/RS Site

2.0 THE DESIGN PROCESS

The design process is described in the subsections which follow. The requirements, workflow analysis, surveys, product tradeoffs, financial analysis, and the system design principles are described.

2.1 Requirements Review

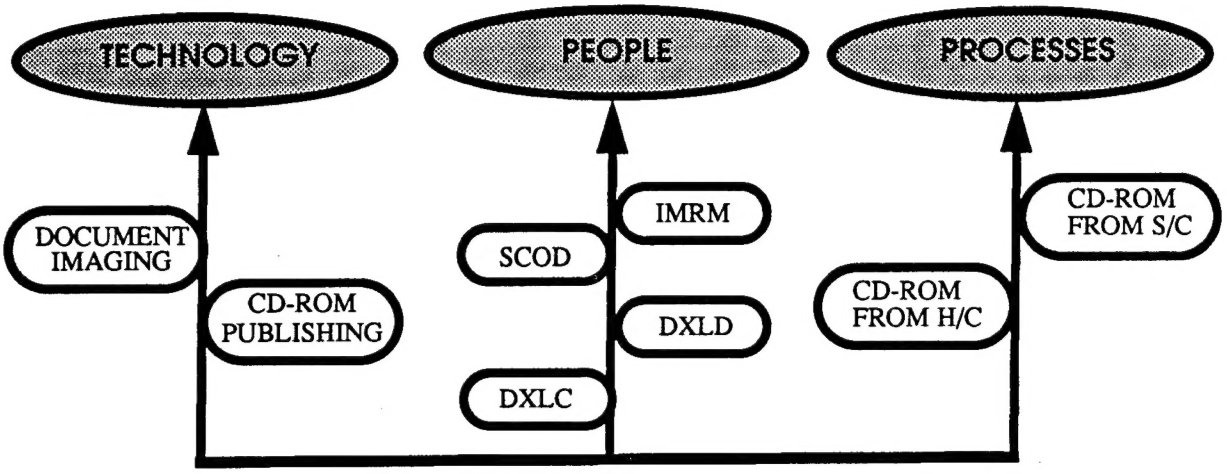
The list of requirements for the Document Delivery System numbered over 80 including SOW requriements and derived requirements. The key requirements are listed in Table 1.

Table 1:

KEY REQUIREMENTS
Information stored on CD-ROM
19" Monochrome Monitor 1280 x 1024
Menu-driven User-Interface
H/C Scanning resolution at least 400 dpi
Scan bound documents
Scan pages from 3" x 5" up to 14" x 20"
Scan pages at an avg. rate of 20 pages/min
Provide for forwd and backwd paging within a document
Magnify small portions of displayed images at a min 4:1
Capability to determine quality of each scanned image
RSS shall provide H/C input to MPS from 4 remote sites
Decompress/Display data on CD-ROMs
Provide 9-track 1600/6250 BPI tape drive with R/W capability
Provide 3480 with R/W capability
Provide 8mm cart tape drive with R/W and 2 GB capacity
Process an average of at least 1000 digital documents/month
Merge files produced on the MPS with those from RSS sites
Retrieve documents from CD-ROM library using document #
DDS shall be maintained at C2 level accreditation

2.2 Workflow Analysis

Workflow analysis was performed on the current process at NAIC. This analysis included over 25 interviews of NAIC personnel to determine what their job is and how they go about performing it. The tasks ranged from sorting and labelling documents to the photographing of documents to be put on microfiche. People at SCOD, DXLC, DXLA, and IMRM were interviewed and process diagrams were created to represent their jobs and the various inputs and outputs that they processed each day. These diagrams are given in Section 8 of the System/Segment Design Document (CDRL X005). After the diagrams were created, they were presented in an outbriefing to about 30 NAIC personnel, and Harris received feedback from this outbriefing which was later incorporated into the revision of the workflow diagrams. The final versions of these diagrams served as the basis for understanding how DDS should be designed to fit into the existing process at NAIC. The process of microfiche creation at IMRM gave insight into the process of document imaging that is part of the DDS process. The QC operations that occur at SCOD led Harris to conclude that the architecture must be modified to incorporate the capability for easy quality control. The result was an ECP which added two new QC stations to the existing hardware, providing NAIC with the capability to parallel those operations currently performed in SCOD. One of the lessons learned on this program was the value of workflow analysis. It was critical to a complete understanding of customer requirements and serves as an excellent input to the design process itself.



DOCUMENT DELIVERY SYSTEM

2.2.1 Control/Data Flow Diagrams

The operational scenario for DDS can also be defined in the context of the Master Production System (MPS), and the Remote Scanning Stations (RSSs). Context Diagrams and accompanying Data Flow Diagrams (DFDs) are shown for the MPS and the RSS. The MPS Context Diagram is shown in Figure 3-1. The inputs are softcopy digital documents. The outputs are a CD-ROM and

8mm archive tape. The Operational scenario is described in terms of the CD Authoring System and the inputs and outputs from storage devices, networks, and physical representations of data such as the hardcopy sheets fed into the scanner. Figure 3-2 is a top-level DFD for the MPS. The inputs are media such as 8mm tape and 9-track tape, and the outputs are TIFF data, a CD-ROM and an 8mm tape of the TIFF data.

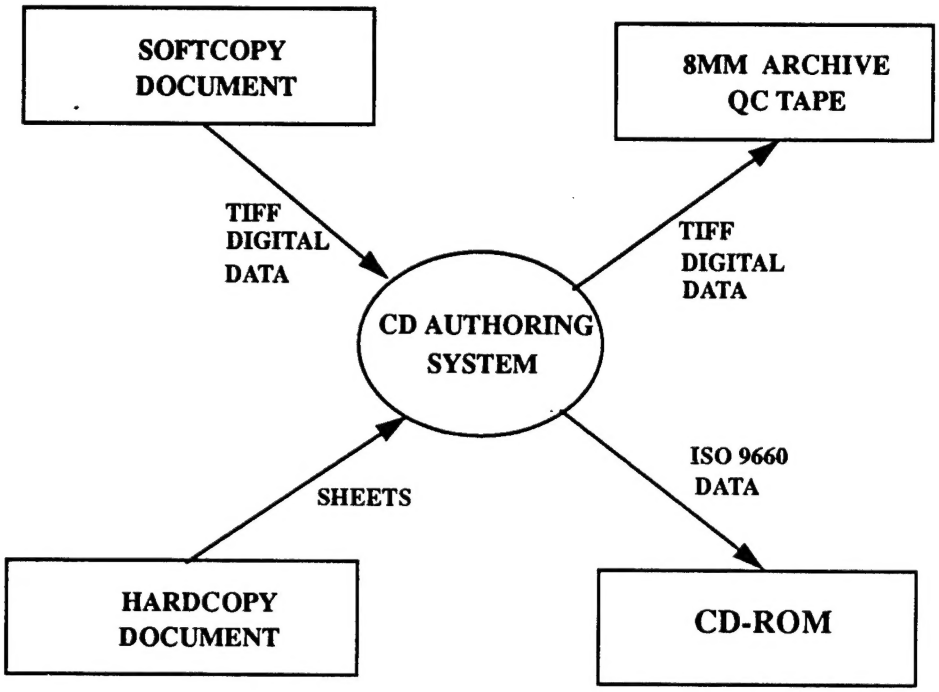


Figure 3-1. MPS Context Diagram

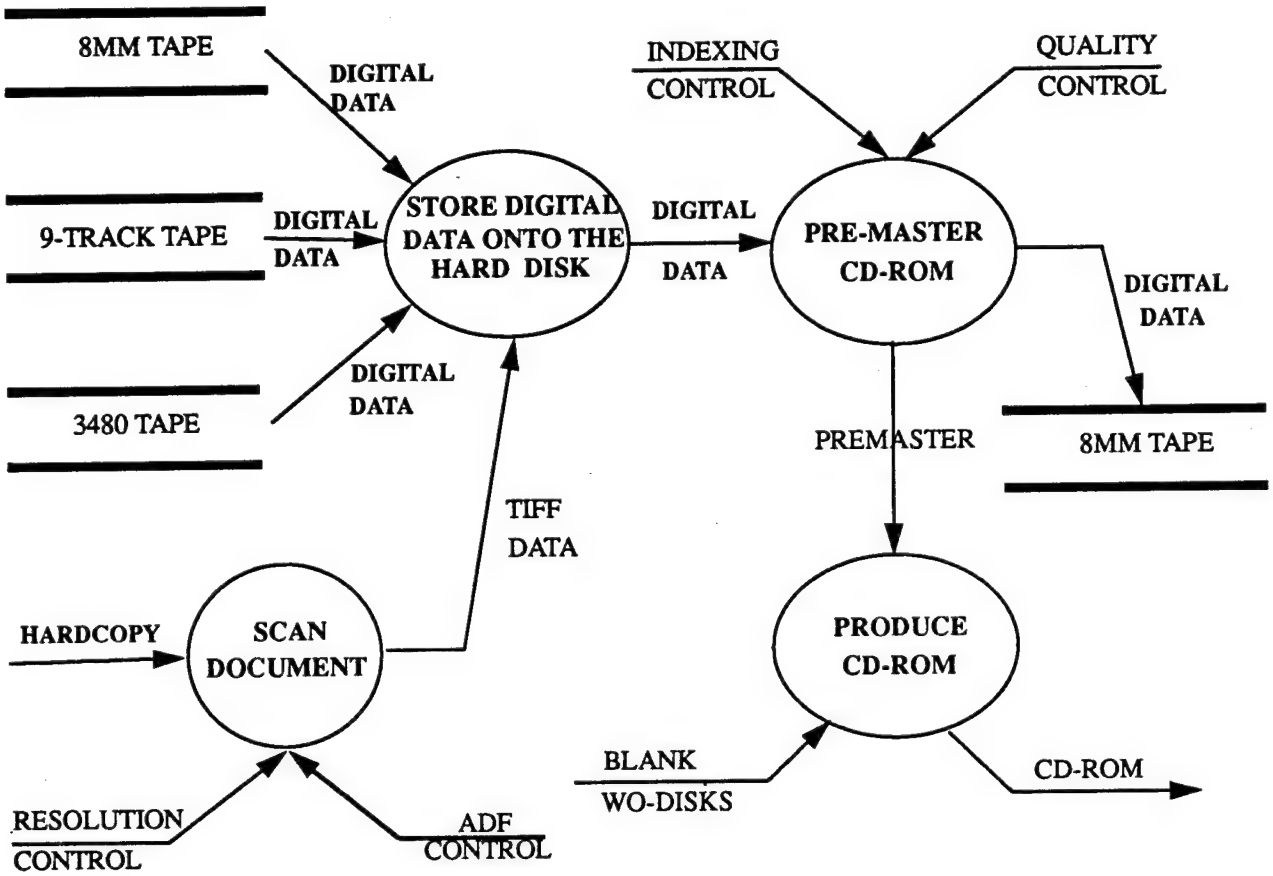


Figure 3-2. MPS Data Flow Diagram

The RSS Context Diagram is shown in Figure 3-3. The Operational scenario is described in terms of the Remote Scanners and the inputs and outputs to/from these scanners. Figure 3-4 is a top-level DFD for the RSS.

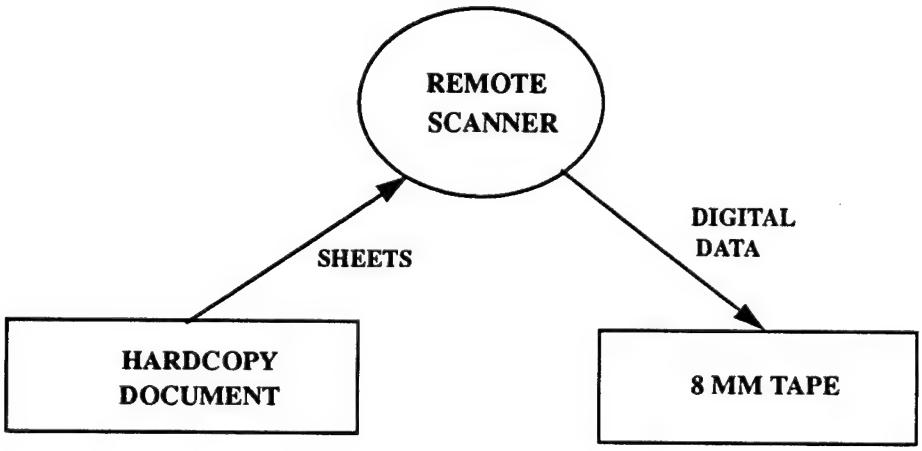


Figure 3-3. RSS Context Diagram

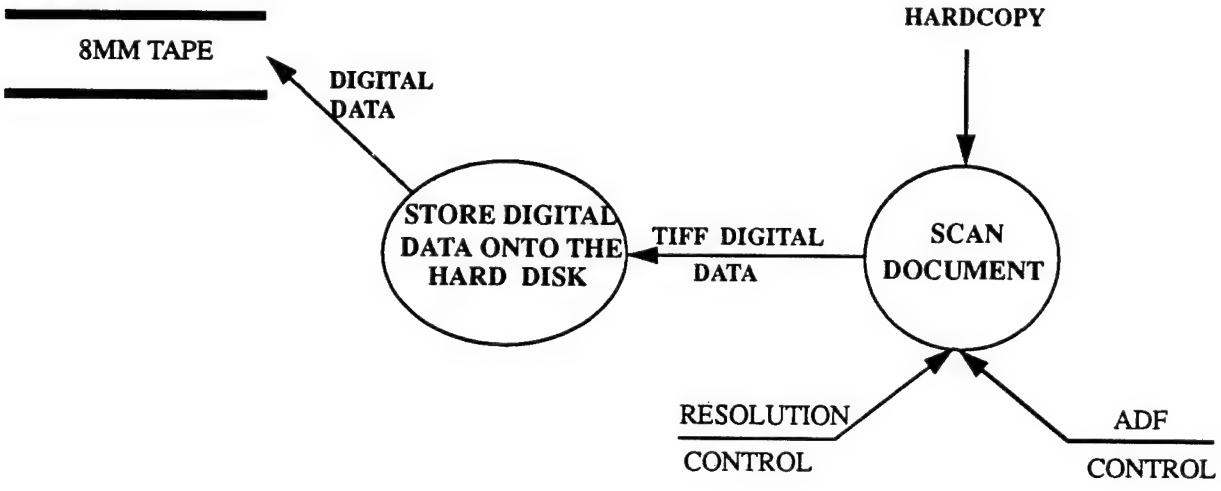


Figure 3-4. RSS Data Flow Diagram

2.3 Surveys

Several surveys were completed to verify the requirements and determine the workflow at the customer sites. The major survey was an on-site survey of NAIC and the processes that take place presently in the microfiche-based CIRC system. Two engineers spent two weeks at site performing a complete workflow analysis, documenting it, and finally making an outbriefing presentation to members of SCPM, IMRM, SCOD, DXLA, and DXLC. This survey was useful in understanding how the present process must be modified to accommodate the new DDS CD-ROM-based system.

Written surveys were also sent out to the remote sites (AFMIC, NAVMIC, FSTC, and MSIC) to determine their hardware configurations and manpower requirements. These surveys determined what additional hardware we would recommend be procured to meet the requirements of DDS for the remote sites.

A set of written surveys was also sent to IMRM at NAIC to determine the types of documents, size, and their physical characteristics. This information helped to determine the products that would best meet IMRM's needs in scanning the vast numbers of documents they must process.

2.4 Product Trade-offs

Appendix A of the System Design Document (CDRL X005) contains many trade matrices which the user can refer to determine how the hardware and software selections were made. The criteria and their relative weights are detailed in that document. A sample trade matrix is shown below.

Table 2: Trade Matrix - CD Authoring Systems

#	VENDOR	PRODUCT	COST	1	2	3	4	5	6	7	8	9	10	TOT
1	Dataware/RTI	CD-Author	19250	1	3	3	3	3	3	3	3	3	3	28
2	Optical Media	TOPiX	4500	3	2	3	3	1	1	3	3	2	2	23
3	MicroRetrieval	re:Search	24000	1	3	0	3	3	3	3	2	3	2	23
4	Meridian	Personal Scribe	14095	2	3	2	2	3	1	0	3	3	3	22
5	Trace	LH-2600	11995	2	2	0	3	2	1	3	3	0	1	17
6	JVC	ROM Maker	12799	2	2	3	3	2	1	0	1	0	2	16
7	Philips	CD-GEN	10145	2	3	0	2	2	1	0	3	0	0	13

2.5 Financial Analysis

A financial analysis was performed on each of the companies that were being evaluated for DDS. A Dun & Bradstreet (D&B) was performed to verify sales figures, number of employees, their paying record, analysts comments, business machinery/equipment and proceeds, and overall rating. Any company with questionable financial statements would be listed as a considerable risk, particularly in the volatile CD-ROM and Document Imaging industries.

2.6 System Design

The system design of DDS was done using CADRE Teamwork and Frame Technologies FrameMaker. Context Diagrams and Data Flow Diagrams were created using Teamwork. Architecture diagrams were graphically drawn using Framemaker. This tool was also used for requirements traceability. Trade Matrices were created to maintain the list of criteria used in making selections of products. Internal engineering reviews facilitated an orderly process for examining the system design.

3.0 THE DOCUMENT DELIVERY SYSTEM DESIGN

DDS consists of three Hardware Configuration Items (HWCIs), which are the Master Production System (MPS), the Remote Scanning Station (RSS), and the Retrieval Station (RS). Each consists of Hardware Components (HWCs), corresponding to individual hardware units.

The system design presented in the following sections describes the specific hardware selections made during the design phase of DDS.

3.1 HWCI Identification.

There are three HWCIs in DDS: the Master Production System (MPS), Remote Scanning Station (RSS), and the Retrieval Station (RS). Each HWCI is described in detail below.

3.1.1 MPS HWCI.

The Master Production System (MPS) HWCI provides the capability to capture information from hardcopy, microfiche, and magnetic media and store it on CD-ROM optical disks for storage and dissemination. The MPS includes three PC workstations located inside a SCIF connected by one Ethernet. Station 1 is dedicated to digital and hardcopy input (scanning images and reading 8mm/9-track/3480 tapes). Station 2 is dedicated to CD mastering and playback (cutting the CD-ROMs and performing QC on them). Documents are read into Station 1 and sent to Station 2 (via Ethernet) for storage onto a CD-ROM. The MPS also includes four PC workstations located outside the SCIF (Stations 3,4,5). Station 3 is used to for digital and hardcopy input of Collateral data, Station 4 is used for CD Mastering of Collateral data, and Station 5 is used for digital and hardcopy input of Unclassified data. The DDS Engineering Change Proposal (ECP) added two new stations: the Quality Control Stations (2A, and 4A), which are used to screen the documents before storage onto CD-ROMs.

3.1.1.1 Station 1 HWC.

This workstation is the input point for all TS/SCI documents. Documents arrive at the SCIF in one of two forms: digital tape or hardcopy. There are three possible forms of digital input: 8mm tape, 9-track tape, and 3480 tape. There are several possible forms of hardcopy input: color brochures, b/w text documents, and bound books. The digital version of the document is stored onto the hard drive and transferred over the Ethernet to Station 2 for CD Mastering.

3.1.1.2 Station 2 HWC.

This workstation is the CD mastering and playback unit, which cuts a set of CD-ROMs simultaneously through a daisy-chained set of SONY double-speed CD-ROM writers. The CD-Author software creates the indexes, the CD-Prepare software generates the ISO 9660 file directory to be stored onto CD-ROM, and CD-Record creates the byte stream to be sent to the SONY drives. Only SCI documents are cut at this station.

3.1.1.3 Station 3 HWC.

This workstation is the input point for all Collateral documents. Documents arrive at the facility in one of two forms: digital tape or hardcopy. There is only one form of digital input for this station: 8mm tape. There are several possible forms of hardcopy input: color brochures, b/w text documents, and bound books. The digital version of the document is stored onto the hard drive and transferred over the Ethernet to Station 4 for CD Mastering.

3.1.1.4 Station 4 HWC.

This workstation is the CD mastering and playback unit, which cuts a set of CD-ROMs simultaneously through a daisy-chained set of SONY double-speed CD-ROM writers. The CD-Author software creates the indexes, the CD-Prepare software generates the ISO 9660 file directory to be stored onto CD-ROM, and CD-Record creates the byte stream to be sent to the SONY drives. Only Collateral CD-ROMs are cut at this station.

3.1.1.5 Station 5 HWC.

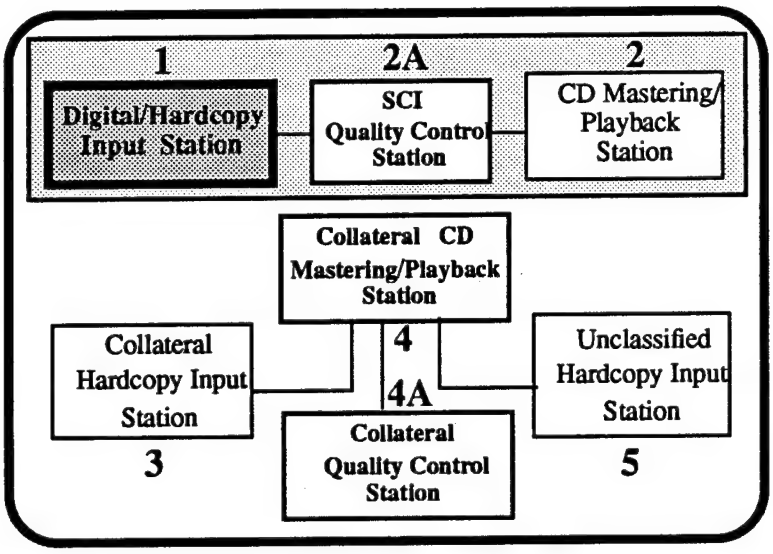
This workstation is the input point for all Unclassified documents. Documents arrive at the facility in one of two forms: digital tape or hardcopy. There is only one form of digital input for this station: 8mm tape. There are several possible forms of hardcopy input: color brochures, b/w text documents, and bound books. The digital version of the document is stored onto the hard drive and transferred over the Ethernet to Station 4 for CD Mastering.

3.1.1.6 Station 2A HWC.

This workstation is the QC point for all SCI level documents. Documents arrive at Station 2A from Station 2 , and the quality control specialist scans the electronic versions of the documents and verifies that they meet quality standards. After this phase is complete, the document has been approved, and is ready to be stored onto CD-ROMs.

3.1.1.7 Station 4A HWC.

This workstation is the QC point for all Collateral level documents. Documents arrive at Station 4A from Station 4 , and the quality control specialist scans the electronic versions of the documents and verifies that they meet quality standards just as was done at Station 2A. After this phase is complete, the document has been approved, and is ready to be stored onto CD-ROMs.

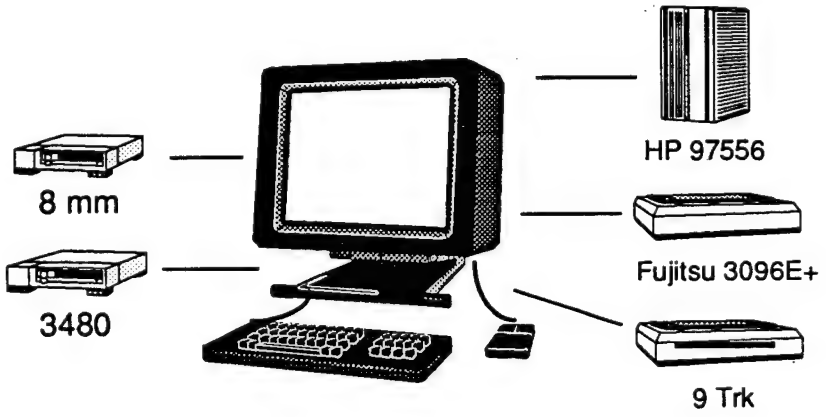


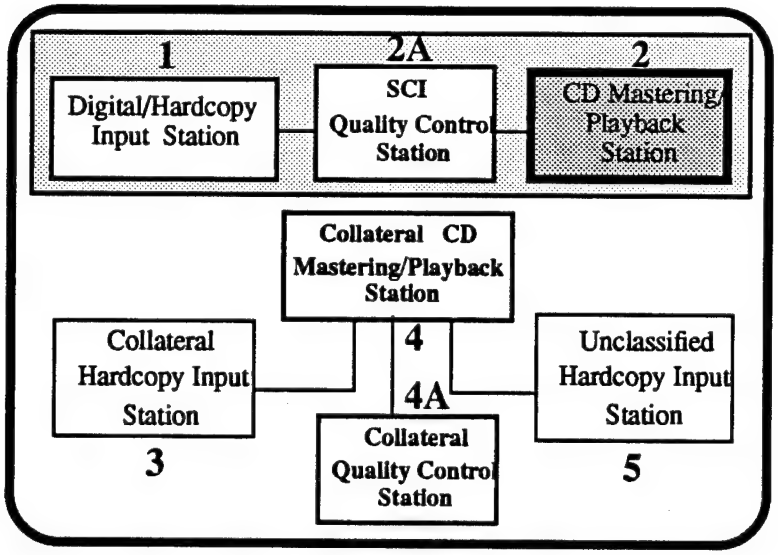
STATION 1 HARDWARE

486 PC [33 Mhz 32 MB RAM]
Laguna 9-track tape drive
Exabyte 8mm tape drive
HP 97556 Hard drive
Xionics Lightening Board
Fujitsu 3096E+ Scanner
19" Cornerstone Monitor / Controller
NI5210 Ethernet Board
Laguna 3480 cart tape drive

STATION 1 SOFTWARE

MS Windows
PC/DACS
Windows for Workgroups
Filemagic
Acefile
Novaback
Hijaak



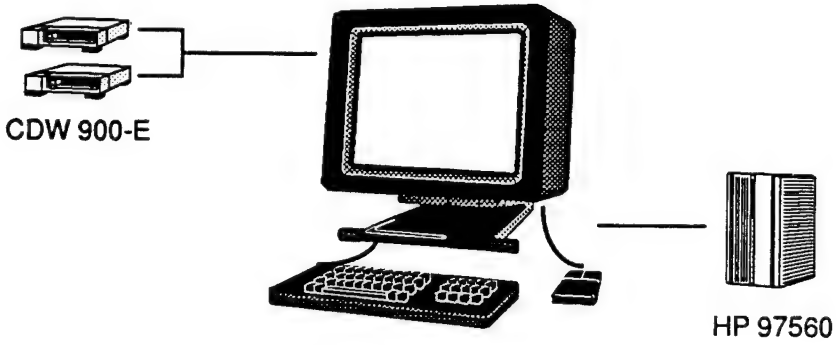


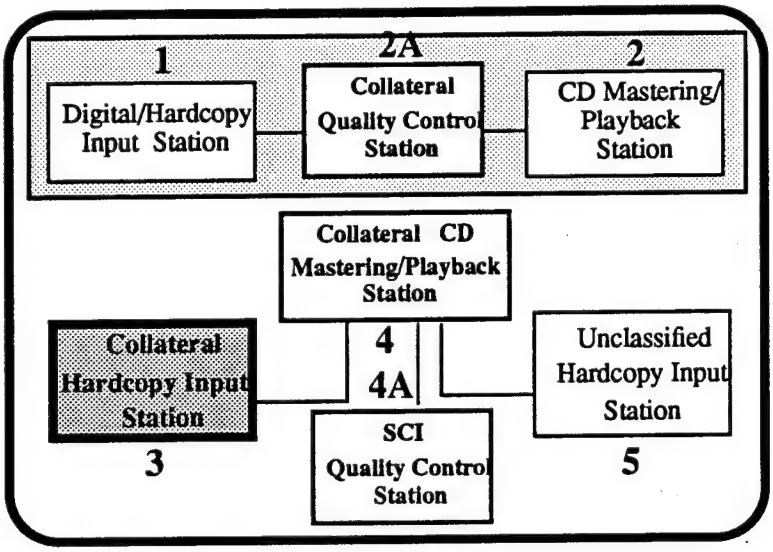
STATION 2 HARDWARE

486 PC [33 Mhz 32 MB RAM]
2 SONY CD-ROM Writers (CDW-900E)
SONY CD-ROM Player (CDU-6211)
HP 97560 Hard drive
Xionics Lightening Board
Adaptec SCSI card
19" Cornerstone Monitor / Controller
NI5210 Ethernet Board

STATION 2 SOFTWARE

MS Windows
PC/DACS
Windows for Workgroups
CD-Record
CD-Author
CD-Answer



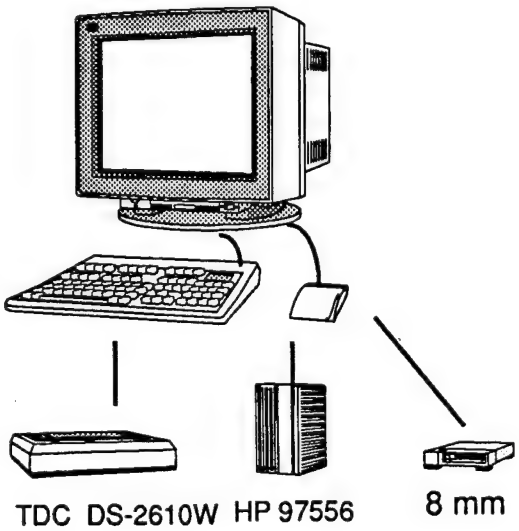


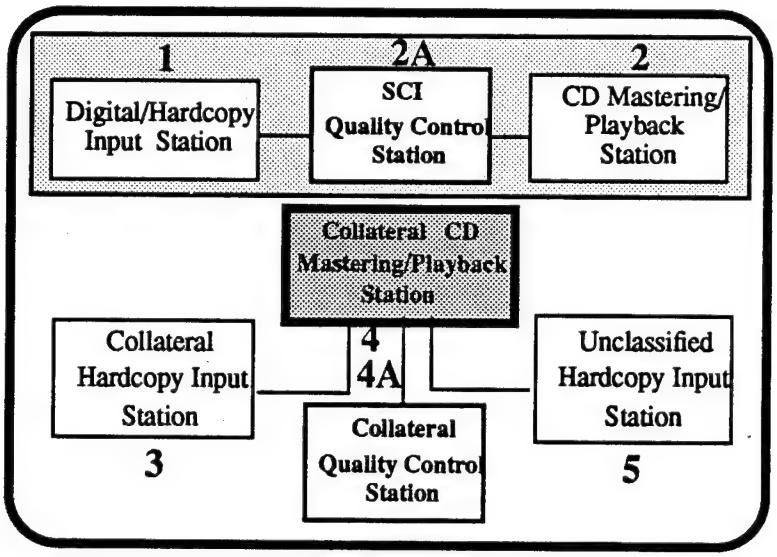
STATION 3 HARDWARE

486 PC [33 Mhz 10 MB RAM]
HP 97556 Hard drive
Exabyte 8mm tape drive
TDC DS-2610W
Kofax Board
Adaptec SCSI card
NI5210 Ethernet Board
19" Cornerstone Monitor / Controller

STATION 3 SOFTWARE

MS Windows
Filemagic
PC/DACS
Windows for Workgroups
Acefile
Novaback
Hijaak



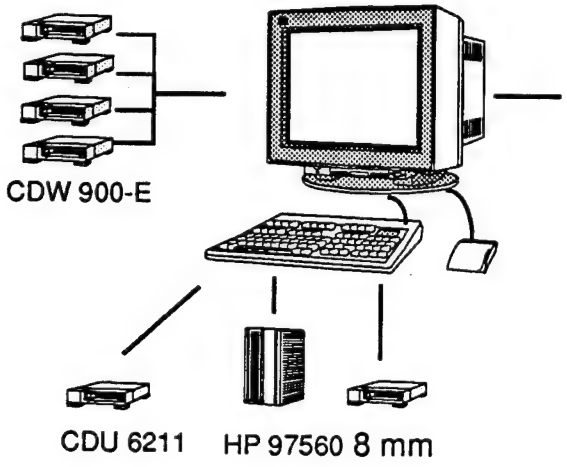


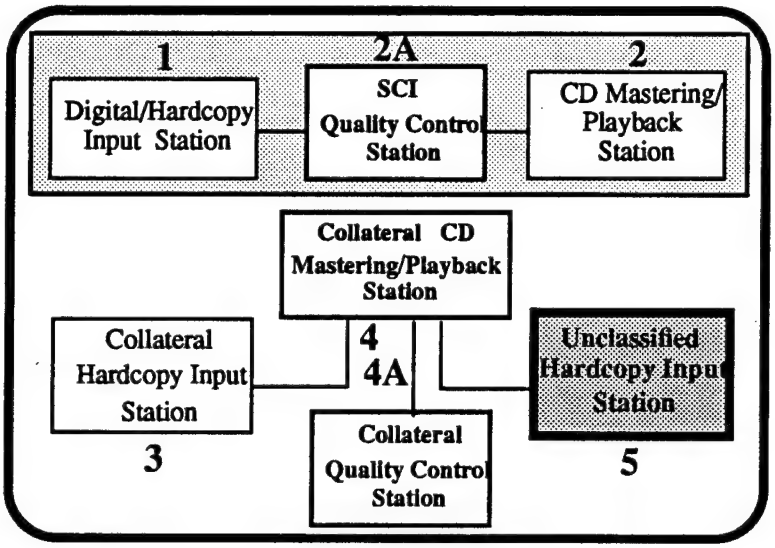
STATION 4 HARDWARE

486 PC [33 Mhz 32 MB RAM]
SONY CD-ROM Player [CDU-6211]
Exabyte 8mm tape drive
Adaptec SCSI card #1 / SCSI card #2
19" Cornerstone Monitor / Controller
HP 97560 Hard Drive
4 SONY CD-ROM Writers [CDW-900E]
Xionics Lightening board

STATION 4 SOFTWARE

MS Windows
PC/DACS
Windows for Workgroups
CD-Record
CD-Prepare
CD-Author
CD-Answer





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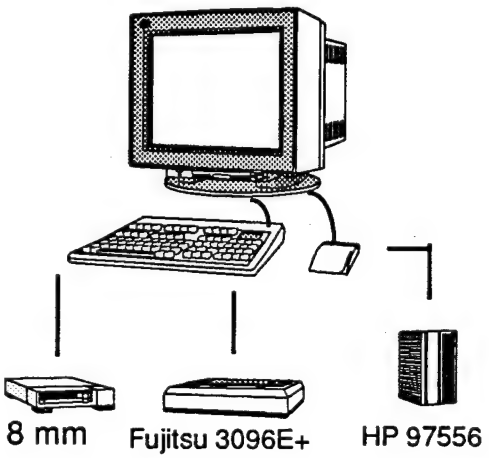

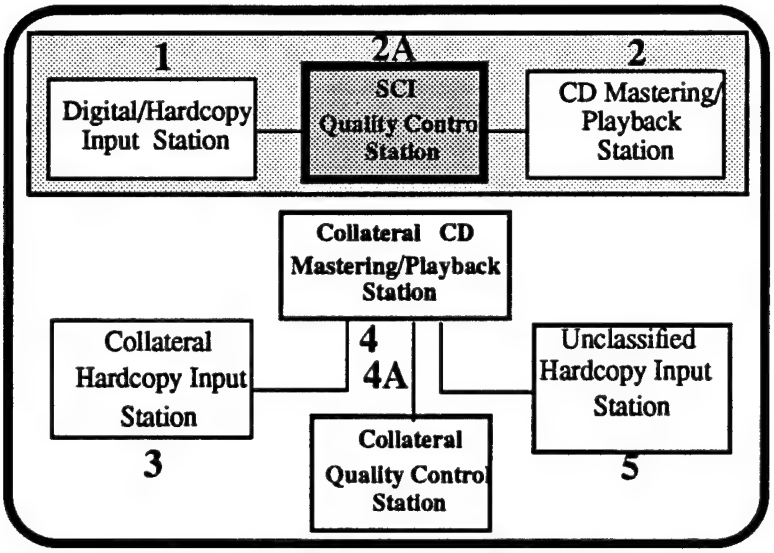

STATION 2A HARDWARE

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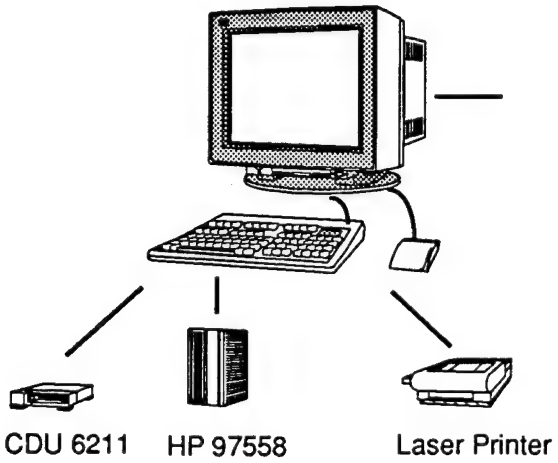
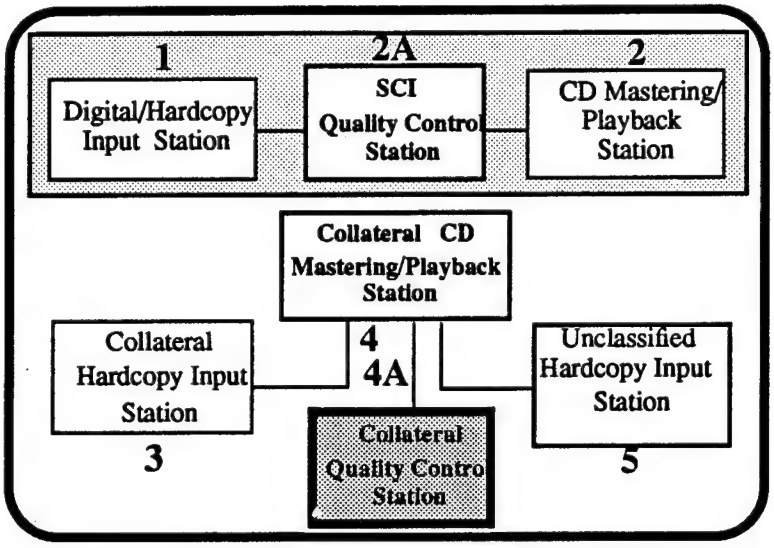
NI5210 Ethernet Board
Adaptec SCSI card #1 / SCSI card #2
19" Cornerstone Monitor / Controller
HP 97558 Hard Drive
IBM Laser Printer

STATION 2A SOFTWARE

MS Windows
PC/DACS
Windows for Workgroups
CD-Answer



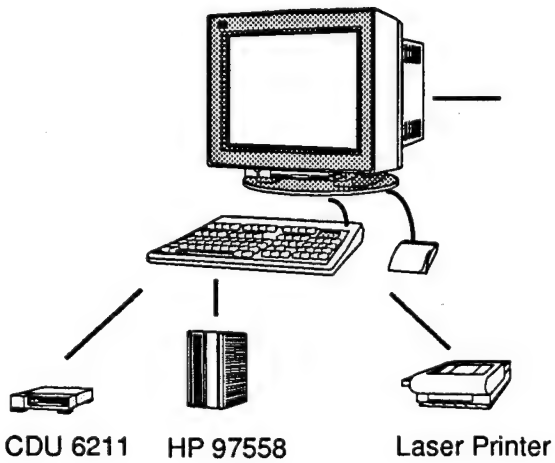


STATION 4A HARDWARE

486 PC [33 Mhz 32 MB RAM]
SONY CD-ROM Player [CDU-6211]
NI5210 Ethernet Board
Adaptec SCSI card #1 / SCSI card #2
19" Cornerstone Monitor / Controller
HP 97558 Hard Drive
IBM Laser Printer

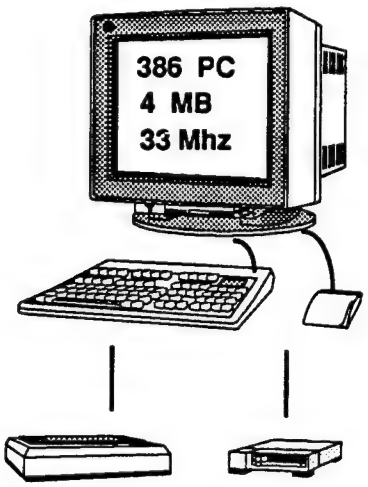
STATION 4A SOFTWARE

MS Windows
PC/DACS
Windows for Workgroups
CD-Answer



3.1.2 RSS HWCI.

The Remote Scanning Station (RSS) HWCI provides a capability similar to the MPS's hardcopy input, at three sites geographically remote from NAIC headquarters. Scanner hardware and software is integrated onto one existing computer system at each RSS site. The media is transferred to NAIC, where it is imported into the MPS at the hardcopy/digital input position, merged with other input data, and written to a CD-ROM.



STATION 6 HARDWARE

386 PC [33Mhz 4 MB RAM]
* Fujitsu 3096E+ Scanner
High-resolution Monitor
Large- MB Hard Drive
* Exabyte 8mm drive
* Xionics Lightening Board
* Adaptec SCSI Card

STATION 6 SOFTWARE

MS Windows
* FileMagic
* PC/DACS

3.1.3 RS HWCI.

The Retrieval Station (RS) HWCI provides the capability to browse, retrieve, and print documents that are stored on CIRC CD-ROM library disks.

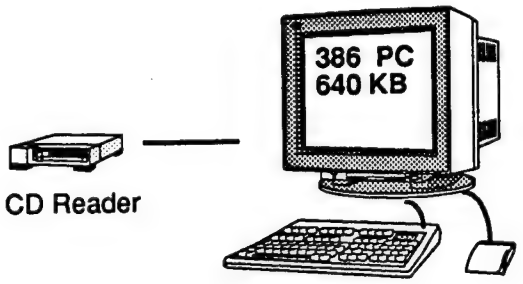


Figure 4-5. Retrieval Station

STATION 7 HARDWARE

386 PC [640 KB RAM]
High-resolution Monitor
100 MB Hard Drive
Laser Printer
CD-ROM Reader
SCSI Card

STATION 7 SOFTWARE

MS Windows
CD-Answer
CD-ROM DOS Extensions

4.0 LESSONS LEARNED

There are some significant lessons learned that shall be addressed in this section. DDS is a pilot program to introduce document imaging and CD-ROM publication to NAIC. The task of integrating a Document Delivery System was challenging given the newness of the technology and the dynamics of the rapidly changing market. The sections which follow address some of the lessons learned and possible steps to take to ensure that the problems are not repeated in the future.

4.1 Document Imaging

Document imaging is a new technology but has recently seen a boom in sales and demand. This technology involves scanning in documents and storing them in electronic format which can be stored onto a computer media such as CD-ROM. Potentially thousands of documents could be stored on a small CD-ROM, and distributed to the masses. The technical problems with this technology are summarized below:

[1] Lack of widely accepted standards

[2] Quality of Document Management Software

[3] Ease-of-Use for Document Management Software

[4] Open Systems Compliant Software

[5] Vendor-Contractor Relations

4.1.1 Lack of widely accepted standards

There are over 60 different formats used in document imaging. The most popular formats include TIF, PCX, and JPEG. However, the products frequently require a specific format that another interacting product does not support. One tool that was integrated on DDS was CD Author, which required FAX G4, a format that our document management software did not support. It is common for one product to require TIFF, when another requires PCX. Different standards can make integration very difficult.

Harris asked Dataware to create a TIFF capability for the CD Author software. The original format required a substantial conversion time and caused long delays in processing. Dataware complied with the request and produced a TIFF-compatible CD Author within two weeks.

4.1.2 Quality of Document Management Software

There are several different document management software products on the market and some of them do not meet the criteria for good quality software. One product, Alacrity, requires a special board to make it run at acceptable speeds, thus driving the up the cost.

4.1.3 Ease-of-Use for Document Management Software

Many of the document management programs have an array of features which frequently inhibit the user's primary function of scanning documents. Workflow is an important feature of many of these tools, but the user-interface is sometimes an impediment. One product, Optika, required the user to go through a series of five or six menus to perform a simple document scan. One product, Keyfile, is designed to be used by Value-Added Resellers (VARs), and as such, is not a plug and go product. Keyfile required some Visual Basic programming to create an interface that would be suitable for DDS. This is a theme that exists at the present in document imaging. Many of the products require lengthy installation procedures, and after that phase, they still need extensive on-site customization to suit the needs of the organization. Optika required three days to get it operational. One product, FileMagic, is very easy to install, and requires only a few minutes of simple customization.

Harris has designed a user-interface which shields the user from this problem through a menu-driven screen in which one button on the screen may perform dozens of commands. The design of the CD-ROM system should incorporate the best HMI possible to make the complexities of the system automated as much as possible. Document imaging likewise has some problems in this area, since there are many hardware issues that make installation sometimes difficult. The paradigm described in previous paragraphs must be reiterated here: hands-on experience is paramount to a successful, user-friendly system.

4.1.4 Open Systems Compliant Software

Many companies make products that are not compliant with the open-systems philosophy. This may have been done in entrepreneurial zeal to protect their product from being undercut by lower-cost competitors or simply an oversight by the designers. One product, Alacrity, requires a special board in order to use it, another product uses an internal image format, which is not one of the standard formats such as TIF or PCX. The open-systems philosophy that is so commonplace in the UNIX world is not as ubiquitous in the IBM PC world. An open-systems architecture ensures that products can communicate with one another, that they have a common language (such as TIF), and common communication channels. A closed system ensures that the user will be restricted to buying supporting software made by that particular vendor and interoperability is made possible only by custom-designed "patch" software. Products chosen for document imaging should be designed with an open-systems architecture to ensure future interoperability with other products.

4.1.5 Vendor-Contractor Relations

The relationship between the vendor and contractor is an important one. The products that the vendors sell are likely to change rapidly as the technology evolves. In the field of document imaging and CD-ROM publishing, every year numerous changes to the products are likely to take place, as new features are added. DDS required the use of products that are in a state of flux, and revisions are released regularly. Sometimes a product has almost all the features that Harris wants, but one or two. For example, CD Author could process FAX G4 well, but had difficulty in processing TIFF. Harris convinced Dataware that the TIFF feature needed to be added. Within weeks, they produced a TIFF utility, which was integrated into the system.

The contractor must have a good relationship with the vendor to be able to negotiate changes to the baseline product in order to meet the customer requirements. The choice of vendor is critical in this instance, since an organization with a limited number of programmers will not like be able to respond quickly when a change or addition needs to be made to the product. Any vendor that is not willing to investigate the product changes or additions that the customer wants is not likely to meet the demands of a project such as DDS. The management of the company should be persuaded that this job is important and will be of great long term benefit to both parties. Good vendor-contractor relations can make a critical difference for the success of the project.

Westbrook Technologies, the maker of Filemagic, was an excellent vendor of document management software. They issued product updates quickly and phone support was excellent. Dataware also had excellent phone support, with over six full time staff available for technical help.

4.2 CD-ROM Publishing

CD-ROM Publishing is another new technology which has spawned numerous vendors touting products which can take electronic versions of documents and "master" CD-ROMs at the users own facility using special CD-ROM writers. The integration problems with this technology are summarized below:

[1] Integration of CD-ROM Authoring Software

[2] CD-ROM retrieval requirements

4.2.1 Integration of CD-ROM Authoring Software

There are several main products which perform CD Authoring (CD Mastering), but each has its own shortcomings. Trade-offs were performed with MicroRetrieval, Optical Media, Merdian, and Dataware, and a few others. Each of these products have been reviewed by Harris and they all appeared to have integration issues that posed potential problems. Meridian does not integrate easily into the architecture Harris designed since it does not allow daisy chaining of CD writers, and Optical Media was reported to have a very difficult and error-prone installation procedure. Harris chose Dataware because they had the best technical support and the best set of product fea-

tures. However, the product, CD-Author, was very difficult to integrate, with dozens of files in various directories, each responsible for different tasks, from indexing to hardware configuration. Maintaining and updating these files was a very challenging task.

The CD-ROM publishing process is complex and the integration of products like CD-Author is likely to remain complex for some time to come. It is recommended that an evaluation copy be obtained to get a realistic idea of the level of effort involved in the integration of a product such as CD Author.

4.2.2 CD-ROM Retrieval Requirements

The other half of the CD-ROM publishing technology is the retrieval software that allows end-users to retrieve documents from the CD-ROMs. The selected product, CD-Answer, allows a user to put a CD-ROM into the reader, and call up documents for viewing. A high resolution monitor such as the Cornerstone is necessary to get a truly good quality image from the retrieval software. These stringent requirements are likely to be around for the foreseeable future. It is recommended that the end-users be made aware that only with the highest quality hardware (monitors, CD-ROM drives) are they going to achieve the best results with the retrieval software.

4.3 Maintenance of Products

The maintenance of the products which were purchased for DDS has been a significant concern since the technology is changing so rapidly that product cycles are short, thus many companies which are successful today may be out of the business in a few years. DDS has been designed with high-quality products which are likely to be supported long into the future. However, the selection of products is always risky in a technology such as CD-ROM publishing or document imaging. Harris recommends the use of a configuration management book, which has a list of the products, and version numbers corresponding to the installed copies of each. As new versions become available, the configuration management book is updated by the system manager. In the event that a company moves, or goes out of business, this fact should be noted in the book. It is important to fill out warranty cards to get the latest software upgraded, which are frequently free for a period of time after the initial purchase. These upgrades should be installed on the system if they contain bug fixes. Periodically, the new upgrades will contain significantly enhanced features, which the end-user of the system may or may not want. This determination is to be made by the system manager. A potential problem with upgrades is that many companies try to sell new features of their product while it is still in the beta-testing phase. This is a product that the end-user should avoid. Some marketers apparently are so used to beta-test software that they describe the features of the product as if it were a released product, when such a scenario is many months away. The responsibility of the system manager is to determine which features are relevant to the operation of the present system and verify that these features have been incorporated into a final, releasable product, not a beta-version.

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